PUBLIC HEALTH REPORTS

VOL. 29. FEBRUARY 13, 1914. No. 7

THE WATER SUPPLIES OF SHIPS.

A DISCUSSION OF THE WATER FURNISHED FOR DRINKING PURPOSES AND OF THE METHODS OF SEWAGE DISPOSAL ON SHIPS ON INLAND WATERS.

By Hugh de Valin, Passed Assistant Surgeon, United States Public Health Service.

The fact that drinking water aboard vessels operating on the lakes and rivers of this country is frequently responsible for serious outbreaks of typhoid fever and diarrheal affections and the generally high incidence of these diseases among crews and passengers clearly demonstrate the immediate necessity for the promulgation of regulations and the adoption of efficient measures to control a situation which is of paramount importance both to the health of the traveling public and the commercial welfare of inland waterway transportation.

Of the outbreaks during recent years, probably the best known and most widely reported in journals and newspapers throughout the country was the one which occurred in the summer of 1907 on a big steamer of the Great Lakes. It is stated that during one short period of the summer's cruise 77 cases of typhoid fever developed as the result of the use of impure drinking water taken from the Detroit River. Surg. L. L. Lumsden, of the United States Public Health Service, states, in his report of an outbreak among 1,200 passengers on a Mississippi River excursion steamer in 1912, that there occurred over 600 cases of diarrhea and 13 cases of typhoid fever with 5 deaths. Investigations by this service of similar outbreaks on three Great Lakes vessels during the summer of 1913 showed that out of a total of 750 people there were over 300 cases of diarrhea and 52 cases of typhoid with 7 deaths.

The foregoing instances do not by any means give a proper idea of the annual number of cases of typhoid fever and intestinal diseases in which the infection is undoubtedly contracted aboard vessels, but are merely cited as being illustrative of the intensity of distinct outbreaks which may occur at any time as a result of the entirely too prevalent use of polluted drinking water on ships. When we consider that the records for the fiscal year ending June 30, 1913, show over 1,600 steam vessels operating on the Great Lakes

alone, and that during this same period there were carried on these lakes over 16,000,000 passengers, it is easy to realize that our inland vessels may play more than a minor rôle in the maintenance of the country's high typhoid fever rate.

In reference to the incidence of typhoid among crews only, it may be stated that during the calendar year 1913 there were treated at the stations of the United States Public Health Service in the Great Lakes region 144 cases of typhoid fever among seamen of lake vessels. The seasonal prevalence of diarrhea among lake crews is so common as to be looked upon by them as normally incidental to the summer's sailing. Though of course the roving life of a sailor exposes him to many sources of infection on shore, from such evidence as is available it may be concluded that a large proportion of the typhoid cases and by far the majority of diarrheal cases among them may be properly attributed to the use of sewage-polluted drinking water on board, the facts developed in the investigations of distinct outbreaks clearly bearing out this deduction.

The character of the drinking water supplied on board ships is chiefly influenced by the amount and extent of pollution of the sources of supply, the responsibility and care displayed in selecting the immediate source, and the vessel's water-intake system.

As to the pollution of our lakes and rivers, it is well known that this has become a serious question and one which is at present demanding the attention of Federal, State, and municipal health authorities. The recent sanitary surveys of the Great Lakes region by the international joint commission have demonstrated that sewage pollution of these bodies of water is yearly becoming more extensive and is proportionately lessening their value as a source of pure water supply. As these lakes are used as cesspools for the sewage of many cities and ships, the amount of pollution is naturally commensurate with the growth of these cities and the increase in shipping.

Undoubtedly there are numerous areas where pure raw water can be obtained, but the extent and concentration of pollution are so variable on account of wind, currents, and other factors, that the customary lanes of travel and limited tank capacity too frequently necessitate a ship's taking water from areas of questionable safety. The effect of this variation in pollution was clearly demonstrated in the case of a vessel, the tanks of which were filled on one occasion when the vessel was about 4 miles offshore from Two Harbors, Minn. The water here is of good depth and generally of safe quality, but this time there happened to be a very strong offshore wind, and evidently sewage had been carried well out, as the subsequent use of the water pumped aboard resulted in a severe outbreak of diarrhea among the crew.

Not only is a ship exposed to city sewage, but to that from other ships as well. Vessels in going from port to port naturally take the shortest route, so there are definite lanes of travel along which an enormous amount of shipping moves. This means that not only are these pathways polluted with ship sewage, but that drinking water for ship use is being constantly pumped from the same areas.

The lack of responsibility and care, so often displayed in selecting the time and place to get water, is probably more the result of habit and ignorance than of willful negligence. Formerly ships could secure good water almost anywhere, and the idea seems to persist that this can still be done, so that there is not the proper appreciation of the necessity for attention to the important details which the present-day conditions demand. If various municipalities have learned by costly experience with typhoid epidemics that not only must extreme care be used in the selection of intake points for water supplies but that in the majority of instances it is necessary to efficiently treat the water before it is safe for drinking purposes, it most certainly follows that ships on these waterways will experience similar trouble unless the same amount of caution is displayed.

Where vessels operate on a definite schedule between ports, and their runs are short, filling tanks is routine duty and falls generally in a certain watch, so water is obtained at about the same place or places on each trip. However, the demand for water naturally varies according to the number of people on board and is therefore very inconstant. If the runs are long or if the ship has no regular schedule for ports of departure and call, there will of course be a great variation in the sources of supply. Aboard most vessels it is the duty of the engineer's department to attend to filling tanks. Very often one man is designated for this duty and always looks after it, but on too many ships there is not only variation in source, but also in the one who selects the source. On more than one occasion tanks have been filled when the vessel was lying in harbor near some sewer outlet because water happened to be needed at the time and some incompetent or careless individual took it upon himself to start the pumps. Again, it has happened that although a safe source has been selected well out from shore, somebody has forgotten to close a valve or stop the pump and the ship has steamed into some foul harbor still pumping water into her drinking tanks. On practically no vessel is any record kept as to when or where tanks are filled, so there is nothing to show just who attended to this duty each time, or what places were selected as sources of supply during a cruise. Many captains and engineers are very careful about this important matter, but still lack of individual responsibility and display of incompetency are very common.

The intake system varies more or less according to type, size, and class of vessel, but in general it may be stated that drinking water is pumped through a sea cock in the ship's bottom to the tanks and delivered from the latter by pipes to drinking points. On some ships there is a separate intake, pump, and pipe line for drinking water, but on by far the majority the sea cock, pump, and main line are used for various purposes, the pipe line to the tanks being a lateral from the main line and closed by a valve when not in use. On most of the freighters and on some passenger vessels the tanks are filled by connecting a hose to the deck line, the tanks having no pipe connection except for delivery of water to drinking points.

As stated above, the intake system is frequently used when water is needed for purposes other than drinking, such as boiler supply, washing down decks, fire control, flushing toilets, filling water-ballast tanks, etc. When lying in port, water for any one of these purposes may be more or less constantly pumped aboard, and if the harbor happens to be grossly polluted with sewage, as practically all harbors are, the sea cock, pump, and pipes must certainly become thoroughly fouled with all sorts of filth. The following extract and the diagram on page 397, both from the article "Water contamination aboard ship and its prevention," by Surg. J. O. Cobb, United States Public Health Service (Journal of the American Medical Association, Dec. 18, 1909), graphically illustrates this point.

All water used aboard, for whatever purposes, is pumped through the sea cocks which perforate the shell of the ship in the bottom, as indicated by the arrow in the diagram, which represents a cross section of a ship, the sea valve, pony pump, and pipes to drinking tanks. Now, suppose that valve A is kept closed when not in use, which is never the case except when the boat is laid up for the winter, then when the ship lies in the Chicago River, say, all that portion of the piping and sea cock from the bottom of the boat to valve A stands filled with sewage, or Chicago River water, which is the same. But let us go further: Suppose that the boat is loaded down so she lies in the water to the depth indicated by B, then the river water would rise through the sea cock to the level of B at C. From the sea cock to the pony pump is a long stretch of pipe in most steamers, and as the pony pump is constantly in action to maintain the pressure in the various pipes and to feed the boilers it is plain that all this section of pipe is filled with sewage all the time that the boat lies in foul water.

Where there is direct pipe connection with tanks, if the valve which closes the tank lateral happens to be left open or is poorly seated, some of the sewage water, which is being pumped through the main, will be forced past the valve and into the drinking tanks. It will be stated on board ship that before filling tanks the intake system is flushed with clean water, but even if this be done—which is not always the case—most certainly the mere washing is not a sufficient surety for the removal of filth and pathogenic bacteria, so that there is always the danger of polluting the drinking water even though the source may be absolutely safe. Obviously an intake

system any part of which is liable to sewage pollution is unfit for service if raw water is to be used for drinking purposes.

The water tanks are variously placed—in the hold, forward, aft, or amidship, or on any one of several decks. They also vary greatly as to number and size, according to the ship they are on, there apparently being no definite scale or standard. As to condition, that varies as much as the tanks themselves. Aboard some vessels they are never cleaned, while on others this is attended to frequently and carefully, steam being often used for the purpose. On some vessels the water supplied to toilet room and cabin faucets for washing purposes does not come from the drinking tanks, but from directly overboard, irrespective of where the ship may be lying. From an esthetic standpoint alone, water out of a dirty harbor seems scarcely

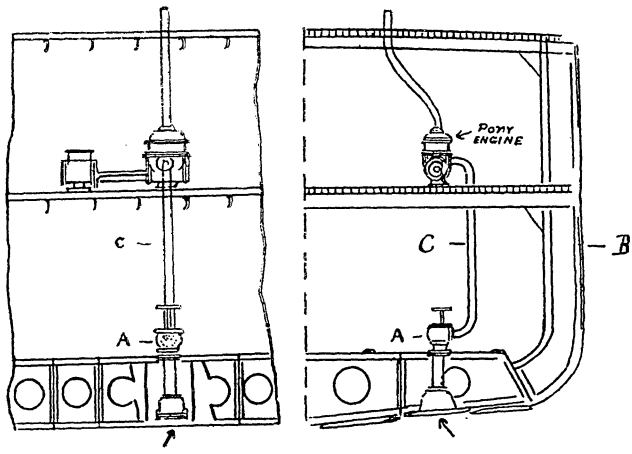

DIAGRAM NO. 1.—Diagram of a ship, showing method of supplying drinking water on shipboard. A, valve to shut off river water; B, C, level to which river water may rise when boat is loaded down. The diagram shows, on the left, a section taken fore and aft, and, on the right, across the hull.

the proper thing for cleansing one's face and hands or for washing one's teeth, but, what is still worse, passengers, through ignorance of the source of supply, not infrequently drink from these faucets.

As to the best way to handle the question of drinking water on board vessels taking their supply direct from our inland waters, there are a few measures which if properly carried out will solve the problem without difficulty.

Extensive pollution of our inland waterways exists and can not be controlled or limited by the ships themselves except in a comparatively slight degree. In regard to responsibility and care in the selection of immediate sources, however, something can be done. There should be some one on board, preferably an officer, whose duty alone it should be to have charge of filling tanks—this to be

done only by his orders and under his supervision—and to make an official entry in the ship's log stating the time and place where the tanks were filled. Though existing conditions prevent absolute certainty as to safety, it should always be endeavored to select places which are known to be free from pollution, and obviously polluted areas, such as harbors and rivers into which sewage is emptied, should be avoided. However, though these precautions will aid materially, it may be stated emphatically that if the supply is taken on board direct from lakes or rivers absolute safety can be assured only by efficient treatment of the water before it is used for drinking purposes.

There are a number of methods of water purification which are recognized as being efficient, but mechanical construction, cost of installation and operation, desired amount of supply, and many other factors will greatly influence their practical applicability to ship use. Some method which can be easily applied, which is not too expensive, which is efficient, and which does not have to depend to any great extent on the human element for operation, should be selected. There is no better purifier of water than heat, and as it is available on practically all vessels, some form of apparatus which uses this as the active principle would be the most feasible. A distilling apparatus meets all requirements, but it is not necessary to distill water in order to render it safe—boiling is sufficient, and there are several devices on the market which operate on the latter principle and are constructed for ship use. The ordinary engineer could no doubt devise some scheme of his own whereby the water would be raised to the proper temperature either before going to the tanks or before delivery to drinking points. Practically automatic operation, however, is a very necessary requisite, in order to avoid the possibility of carelessness or negligence on the part of some one.

Ozonization is a method which is rapidly coming into general use and there are various satisfactory ozonizers made for application to ships' water supplies.

Filters are to be condemned. Though many accomplish mechanical cleansing, very few can be depended upon for the constant and complete removal of harmful bacteria, and those types which are efficient are not constructed to meet the demands of a vessel's water supply. The sand and gravel type of rapid filter is frequently seen aboard ship, but though applicable to municipal use, the manufacturers themselves admit that filters of this class for ship use can not be depended upon always to deliver safe water. For one thing, frequent cleaning is necessary and this is a precaution which can very easily be neglected so that often the filtered is much more dangerous than the raw water.

As to the method of intake now in general use, though no doubt objectionable, it is not directly harmful if the water is properly treated

before it is used for drinking purposes. If the water is not treated, the method is decidedly dangerous and should be abandoned. Under any circumstances, a change should and can be easily made. A separate intake device, which can be raised above the water line when not in use and so be free from pollution while in harbors, and a separate pump and pipe line to be used only for filling tanks, would meet the necessary requirements.

The practice mentioned before of taking water from directly overboard for personal toilet use should be abandoned, as it exposes crews and passengers to the danger of infection. People can not be depended upon to stop and inquire if this or that water is intended for drinking, so it is imperative that no water, unless it comes from the drinking water system, be accessible for this purpose.

One of the best ways for vessels to avoid the dangers of uncertain sources and of contamination by faulty intake systems is always to get their drinking water from the municipal supplies in the ports visited. Most of our large cities have adopted measures to provide safe water and ships can easily take advantage of the opportunities thus afforded. Such things as tank capacity, number of people carried, length of trips between ports, etc., must be taken into consideration, but no doubt many vessels will find that the cheapest and easiest way to solve the problem will be to so increase their tankage that they can depend solely on municipal supplies for drinking water. There will then be no necessity for communication between sea cock and tanks, as the latter can be filled by attaching hose to city connections on the water front.

There is another question which has a direct bearing on the one of pure-water supply, and that is the disposal of ship sewage. The present practice is to discharge all sewage from toilets directly overboard. Though the point that the amount of general pollution of waterways by ships is small in comparison to that by cities is well taken, it can not be denied that in many instances sewage from ships may do a great deal of harm. As mentioned before, there are certain definite lanes of travel up and down which hundreds of ships pass, discharging their sewage as they go, so that the possibility of a ship taking on human filth along with her drinking water, if she happens to be following fairly close in the path of another vessel, is not so remote as one might suppose. Aside from the danger to one another, the promiscuous discharging of sewage by ships is very often a decidedly grave danger to cities. In the case of some of our Lake cities, the water intakes are so placed that ships frequently pass very close to them. It can be readily seen that a large vessel coming into port with several thousand people aboard may cause highly concentrated pollution of the area from which the city draws her drinking water. In Chicago, at least, this danger has been recognized and the health

department is requiring vessels which use this port to install carrying devices, so that no sewage may be discharged within a certain distance of the intakes or while in harbor. Diagram No. 2 illustrates the type of sewage tanks being installed on the ships of one of the Chicago lines. Each tank accommodates one, two, or three toilets. Their capacity is rather limited—the largest being only 12 by 44 inches—and therefore necessitates frequent emptying. They are designed as temporary carriers only, the raw sewage to be discharged when the ship is out in the lake, and by no means meet the proper requirements, but they are at least a step in the right direction. There is ample steam on most vessels, so that a tank or tanks somewhat of this type could no doubt be devised in which steam could be used as the sterilizing agent and the sewage efficiently treated before discharge, thereby doing away with any danger irrespective of the place of ultimate disposal.

From the foregoing facts and statements relative to water supply and sewage disposal on ships, it may be seen that the present existing conditions can be improved with comparative ease if proper cooperation and effort are made by the shipping people. The question of ship sanitation is important not only from a public health standpoint, but from a commercial one as well, for the public at large is beginning to take a genuine interest in such matters, and the companies affected by the outbreaks mentioned in this article can vouch for the fact that a ship which exposes her crew and passengers to unnecessary dangers receives unenviable advertising.

Gastroenteritis and Typhoid Fever among Personnel of Steamship Gopher.

The *Gopher* is a vessel of the United States Navy assigned to the naval militia of the State of Minnesota for use as a training ship.

The itinerary of the cruise during which the outbreak occurred was as follows: Ship left Duluth, Minn., at 6.42 p. m. August 7. Passed through locks, Sault Ste. Marie, at 9.40 a. m. August 9. Tied up at dock, Sault Ste. Marie, 9.56 a. m. same date. No general shore liberty granted, but men were allowed ashore on dock and adjacent common for a short period. Ship under way at 12.33 p. m. August 9. Arrived at Mackinac Island 8.31 p. m. August 9, and came to anchor in harbor. Liberty party (about one-half ship's company) ashore at 9.10 p. m., returned to ship at 10.50 p. m. Ship under way at 4.45 a. m. August 10, came to anchor, South Manitou Island, at 1.53 p. m. same date. Ship remained in neighborhood of South Manitou until morning of August 12. Shore liberty was granted several times at this port, practically entire ship's company taking advantage of the opportunity to go ashore. Quite a number of the crew were in swimming on August 11 while the ship was at anchor.

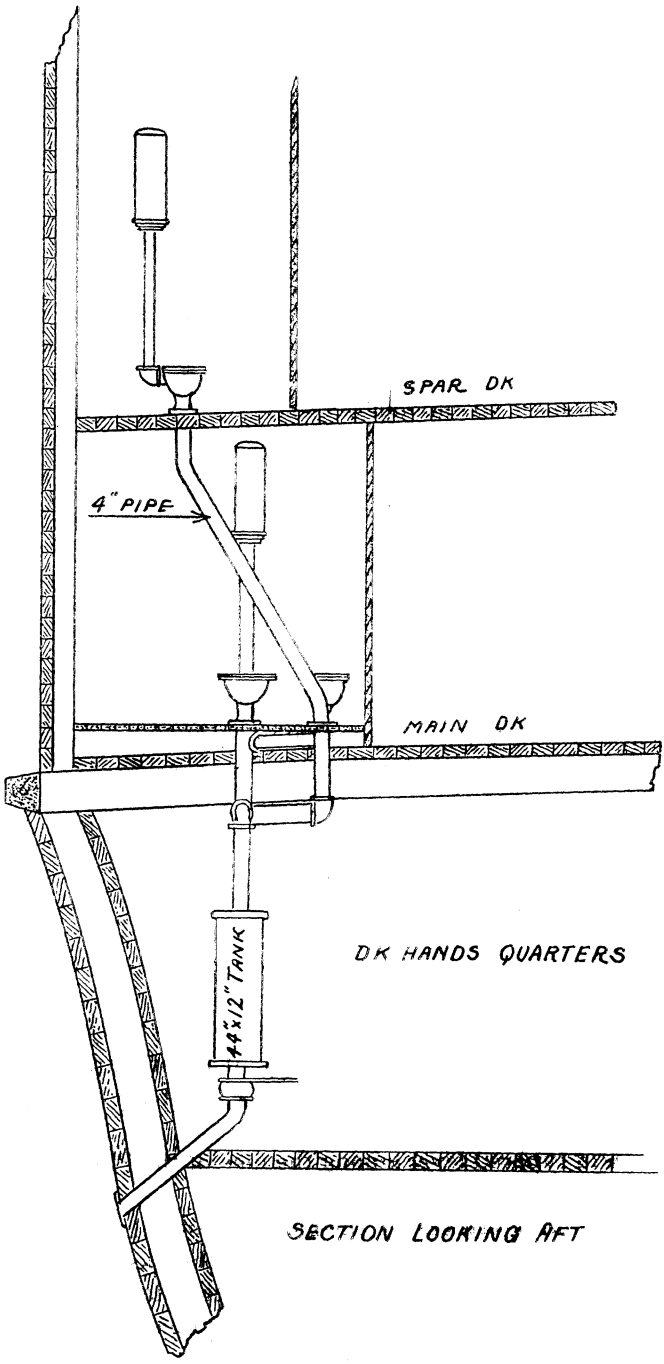
SPAR DK
4" PIPE
MAIN DK
DK HANDS QUARTERS
44 X 12" TANK
SECTION LOOKING AFT

DIAGRAM NO. 2.

The U. S. S. *Dubuque* and U. S. S. *Don Juan* were at South Manitou at this time and numerous visits were exchanged between the crews of the three ships. At 10.02 a. m. August 12, the *Gopher* got under way for Milwaukee, Wis., coming to anchor in that harbor at 5.10 a. m. August 13. Went alongside coal dock at 11.40 a. m.; returned to anchorage at 6.10 p. m. While at Milwaukee the entire crew was granted shore liberty. Ship again under way at 5.02 a. m. August 14, proceeded to Chicago, Ill., and came to anchor off the United States naval training station at 11.51 a. m. same date. A party of 130 men from the training station was taken on board and the ship proceeded to the city, coming to anchor in the Chicago basin at 5.55 p. m. The training station party was then disembarked. Shore liberty granted to one-half of *Gopher* crew at 7.45 p. m.; liberty party returned to ship same night. Ship under way at 6.56 a. m., August 16, proceeded to Milwaukee, coming to anchor in that harbor at 2.19 p. m. same date. Got under way at 4.34 p. m. and joined other ships about 20 miles off Milwaukee for fleet maneuvers. Again proceeded to Chicago on August 16, coming to anchor in basin at 6.58 p. m. same date. Ship remained at Chicago until noon of August 18. Liberty parties ashore in city on August 16 and 17. Ship got under way at 12.11 p. m. August 18, made short run, and returned to Chicago. Remained at Chicago until 3.50 a. m. August 20, when she proceeded to Mackinac Island, arriving at 10.05 a. m. August 21. Went alongside dock to coal. Very few men ashore at this place. Under way again at 12.46 p. m. August 21, passed through locks Sault Ste. Marie 9.11 p. m. same date, and proceeded to home port. Arrived at Duluth August 23 and tied up at her dock at 2 p. m. This being the end of her cruise, the officers and crew proceeded to their respective homes.

Of the 143 members of the ship's company, 102 were from Duluth and its immediate neighborhood, and 41 were from Pine City, Minn.

From data obtained by personal interview with officers and enlisted men living in Duluth and Pine City, it is estimated that about 60 per cent of the members of the ship's company had gastrointestinal disturbances during the cruise.

Three cases of typhoid fever among the men of the Pine City detachment were reported.

The general characteristics of the gastrointestinal cases were similar to those which have been noted in outbreaks of this nature occurring among crews and passengers of other lake vessels during the summer of 1913, except that in this instance the attacks were shorter and lacking in severity of symptoms.

Diarrhea was the most prominent symptom, and in all but a few cases, the only one. It was of mild type and short duration, the average being about one or two days.

In addition to the diarrhea, a few cases presented the following symptoms in varying combinations—nausea and vomiting, general malaise, headache, and abdominal cramps.

None of the cases gave history of fever. A review of the medical records of the cruise showed practically no absence from duty on account of the attacks.

It was noted that a larger percentage of the men from Pine City was affected than those from Duluth. The Pine City men were for the most part newly enlisted and had never been on a cruise of this character before, whereas those from Duluth had been members of the organization for a longer period, and the majority had been on similar cruises during former years.

Relative to the time of onset of the cases, the investigation showed that the majority developed during the period of August 12–14, five days after the beginning of the voyage.

The three typhoid patients all gave history of primary diarrheal attacks beginning, as near as they could recall, about August 12 or 13, and continuing for two weeks, nine days, and three weeks, respectively. The respective dates of onset of the definite typhoidal symptoms were August 31, September 2, and September 9.

The State laboratory reported positive Widals for all.

To determine whether the gastrointestinal infection had been contracted on shore or on board ship, careful inquiry was made relative to food, milk, water, etc., used on shore at the various ports visited. Though practically all the men interviewed stated that they ate and drank in varoius restaurants, hotels, lunch rooms, etc., at the different ports, and drank from the public water supplies in numerous places, as far as could be determined no large proportion of the cases ate or drank at any one place on shore. The character of the outbreak pointing undoubtedly to a common source of infection for all the cases, and the evidence failing to demonstrate the probability of such infection having been contracted on shore, it was concluded that the source of trouble was on the ship itself.

There have been no reports of similar outbreaks occurring during the past summer at any of the places visited by the ship, nor in either Duluth or Pine City, the home cities of the men.

With the exception of the three typhoid cases among the Pine City detachment, it was stated that there had been no cases in Pine City this year. The history of these three cases showed no absence from home prior to the cruise or the probability of the patients having contracted the infection at any time other than while on the cruise. As far as could be determined these men gave no history of a probable common source of infection on shore or of the likelihood of any of them having contracted the disease at any port visited by the ship.

It was therefore concluded that their infection was contracted on board.

The factors on board ship which were considered as possibly operative in causing the outbreak were milk, ice, water, and other foods.

As far as could be learned the milk, ice, and other food purchased were of good quality and there were no reports of similar illness among other customers who had purchased from the same dealers.

It may be stated, however, that on the part of a number of the men there was complaint relative to the meats served at times during the cruise. It was said that on more than one occasion the meat was tainted. This evidence was not sufficient, however, to point to food as a probable cause of an outbreak of the type in question, though improper food in some instances may have acted as a contributing factor.

So few of the cases gave history of having used milk that milk was easily eliminated as a probable factor.

The relatively small amount of ice used and the absence of any reason to suspect the high degree of contamination which necessarily would have had to exist also eliminated ice as a probable cause.

There was no history of any case of typhoid or of the presence of a probable carrier among the ship's company during the cruise.

In reference to the drinking water used on board, it was stated to have been obtained as follows: Tanks and scuttle butt filled on August 7 about 4 miles off shore from Two Harbors, Minn.; hose allowed to run a few minutes before filling tanks. Tanks again filled on August 15 when about 25 miles out from Milwaukee, and about 15 miles off shore. Scuttle butt filled by hose on August 13 on way from South Manitou Island to Milwaukee. Scuttle butt filled by hose twice on trip from Chicago to Mackinac Island, August 20 and 21. Tanks again filled after getting into Lake Superior on return trip. Scuttle butt frequently filled during the trip by carrying water from main tanks.

As it is not the custom on this or any other lake vessel to make a record of when and where water is taken on, the above information was furnished from memory by the petty officer having charge of the tanks.

There are four water tanks of about 150 gallons capacity each on the berth deck. These are filled with a hose connected to the main deck pipe line, the water being pumped through a sea cock in the ship's bottom. The tanks themselves have no pipe connections.

The scuttle butt stands on the port side of the main deck near the galley. It is an oblong wooden box with a three-compartment zinc water container inside, the middle compartment for water and the end ones for ice. There is a circular opening, with detachable cover, in the wooden cover of the scuttle butt through which water

is dipped when desired. The container is filled either with the hose above mentioned or by carrying water from the main tanks below.

It was stated that before filling either the tanks or scuttle butt with the hose the water was allowed to run free for a few minutes in order to cleanse the pipe line. As this same pumping system is used for washing down decks when the ship is in harbors, there is every opportunity for its becoming grossly polluted throughout. Simple flushing before filling tanks, even though at the time the source of drinking water may be safe, does not guarantee sufficient cleansing to eliminate the possible contamination of the supply from dirty pipes.

The water which is supplied to the officers' rooms and galley for washing purposes does not come from the tanks but is pumped from directly overboard through the sea cock and distributed by piping to the delivery faucets.

It can readily be imagined what character of water is thus supplied when the ship is lying in some sewage-polluted harbor. The system is obviously a dangerous one, as it was acknowledged by several that on more than one occasion they drank water from these faucets.

In reference to the character of water obtained from the sources previously mentioned, it may be stated that during the past summer another vessel gave a history of having filled her tanks when about 5 miles off Two Harbors and a severe outbreak of diarrhea among the crew developed.

As regards the supply from Lake Michigan, in taking on water between Milwaukee and Chicago, unless extreme care was used in selecting the source according to distance from shore, depth of water, set of currents, etc., there was ample opportunity for the *Gopher* to take her supply from an area more or less polluted with sewage.

Taking into consideration the fact that similar outbreaks, directly traceable to polluted water, occurred on other lake vessels during the summer of 1913, that there were many opportunities during the cruise for the drinking water to have been taken from polluted sources, that even though the source may have been safe there was every opportunity for pollution of the supply by the intake system, that the evidence pointed to the infection having been contracted on board ship only and eliminated factors other than water as the cause, I am of the opinion that the outbreak of typhoid fever and gastroenteritis aboard the *Gopher* was caused by infection in the drinking water furnished to the ship's company during the cruise in question and that this impure supply was probably taken on board prior to August 12 as the intensity of the outbreak made itself manifest during the period August 12–14.

RECOMMENDATIONS.

That whenever water is taken on board for drinking purposes it shall be done only by the order and under the supervision of a commissioned officer, and an official entry shall be made in the ship's log stating the time and source of supply.

That the present scuttle butt be replaced by one which will protect the contained water from contamination, fitted with a sanitary drinking faucet in order to avoid the use of a common drinking cup, and with the water and ice compartments so arranged that no ice shall come in direct contact with the water.

It would be much better, however, to abandon the use of a scuttle butt and to have the drinking water delivered under pressure through pipes from the main tanks to one or more drinking faucets on the main deck. For cooling purposes the piping can be arranged in the form of a coil at some point and ice packed around it. On many ships the coil is in the main ice box.

On account of the increasing pollution of the Great Lakes by sewage and the consequent danger in the use of raw water, no water which is taken on board at any place in the Lakes should be used for drinking purposes until it has been so treated that it is rendered absolutely safe. Any one of several methods of water purification could no doubt be applied in this case, but in view of the many points which would have to be considered in reference to operation and efficiency, I am of the opinion that some form of apparatus for the purification of water by heat would be found to be the most satisfactory in meeting the necessary requirements. Even though the water be efficiently treated, proper care should be used in the selection of the source of supply, and places avoided which are obviously liable to sewage pollution.

Some other method for filling the tanks should be used. The intake system for drinking water should be used for that purpose alone and so constructed that it will not be liable to contamination by sewage when the ship is lying in harbors.

The present system for delivering water from directly overboard to the galley and officers' quarters should be abandoned or so changed that the water furnished shall come from the tanks only.

Some efficient method of refrigeration should be adopted so as to assure the proper preservation of meats and other perishable foods during the cruise.

Gastroenteritis and Typhoid Fever among Passengers of Steamship Huron.

The *Huron* is a passenger steamship of the Star-Cole Line plying between Cleveland, Ohio, and Sault Ste. Marie, Mich., via the Georgian Bay route. She makes regular weekly runs from June 30 to August 31, sailing from Cleveland every Monday and returning the following

Sunday. Her regular ports of call are: Cleveland, Ohio; Toledo, Ohio; Detroit, Mich.; Port Huron, Mich.; Goderich, Ontario; Kincardine, Ontario; Killarney, Ontario; Little Current, Ontario; Manitowaning, Ontario; Bruce Mines, Ontario; Hilton, Ontario; Richards Landing, Ontario; and Sault Ste. Marie, Mich.

The outbreak investigated occurred during the last trip, August 25–September 1, 1913. Owing to a severe storm the ship remained at Killarney, Ontario, over August 29, so did not arrive at Cleveland until September 1, one day behind her regular schedule.

Most of the passengers boarded the ship at Cleveland, Toledo, or Detroit, and made the round trip, though quite a number came aboard at the various ports in the Georgian Bay district, having gone up on previous trips. Coming down, the passenger-carrying capacity of the ship was rather severely taxed, as there were fully 300 people on board.

As the passengers were from various sections of the country, it was impracticable to see them all, but a sufficient number were interviewed, either by personal visit or letter, to enable me to obtain, with the aid of information from other sources, ample data relative to the character and cause of the outbreak.

The symptoms of the gastroenteric attacks were the same as those noted and reported in other outbreaks of similar character. Diarrhea was the most prominent and constant symptom, varying in duration from a few days to several weeks. In general the stools were very loose and watery. A number of the cases had severe abdominal cramps accompanying the diarrhea and others gave history of the attack being ushered in with more or less nausea and vomiting. In many the diarrhea was intermittent in type, especially in those cases of several weeks' duration. A small proportion had fever during the attack, accompanied by more or less prostration, headache, and general malaise.

From the data collected it is estimated that at least 50 per cent of the passengers were involved in the outbreak.

Relative to the time of onset, the greatest number of cases developed during the period August 27–29, and of these the majority occurred on August 27. The outbreak was almost solely confined to those passengers who boarded the ship at the ports touched at early in the week and who made the round trip, very few of those who came on board at the various Canadian stops during the return journey from Sault Ste. Marie being affected.

The character of the outbreak clearly pointed to a common source of infection for all the cases, so taking into consideration the fact that the passengers came from many different points by various railroads, and that the outbreak did not develop until after the start of the cruise, the probability of the infection having been contracted

otherwise than during the course of the steamer's trip was safely eliminated.

There are no reports of similar outbreaks having occurred during the past summer at any of the ports visited.

Relative to the possibility of the infection having been contracted on shore at any place visited during the cruise, only a few of the cases gave history of having eaten or drunk anything at any port with the exception of Sault Ste. Marie. Here nearly everyone had dinner at the hotel on August 28. Therefore, this was the only place which might be suspected, but it also was eliminated as a probability, as the intensity of the outbreak had made itself manifest before the ship's arrival at this port.

Bearing in mind that drinking water has been proved to be the source of trouble in several similar outbreaks, an investigation relative to that used on the *Huron* was made. A thorough inspection of her water system was made by Asst. Surg. Joseph Bolten at Detroit, and I quote as follows from his report:

The boat receives its water directly from the lakes (Erie, St. Charles, Huron, etc.) by means of one large and one small pumping engine stationed on the lower deck. These pumps force the water into three large tanks, of 120 gallons capacity, situated on the starboard side of the hurricane deck.

The large pumping engine supplies two of these tanks, and is used only when the supply in them becomes insufficient. The smaller engine supplies the third tank with water and is in use continuously. The tanks supplied by the large pumps are the reservoirs for the drinking water and water used in the kitchen and pantry, respectively. These tanks have separate overflow pipes which empty directly into the paddle box, over the water.

The drinking water is conveyed through iron pipes, from the tank for this purpose, to the ice chest on the lower deck. There it is cooled by cakes of ice lying in close proximity to the water pipes. From the ice chest the water is then conveyed by means of pipes to the cabin deck, where passengers may drink by opening the tap connected with the pipes, there being no reservoirs to hold the water on this deck. There are two of these taps on this deck. In addition, there are two water stands containing bottles of water, from which passengers may drink. No sanitary cups or appliances for holding same were in evidence at the time of the investigation. The crew has a separate tap on the lower deck connected directly with the ice chest. At no time was there any possibility of the water becoming contaminated by ice in its passage from the tank to the passengers.

The tank for holding the water used in pantry and kitchen has the same supply pipe as the drinking-water tank, but has its own pipes leading to the pantry and kitchen, the latter being situated on the lowest deck of the boat, a few feet below the water line. As I said before, the above two tanks receive water by means of the large pump, which is used only when the supply in the tanks is low.

The third tank is placed alongside the other two tanks and is the reservoir for the toilets and wash rooms. This tank is supplied by the small pumping engine, which is in use continuously, drawing water from whatever source the boat happens to be in. This tank also has an overflow pipe leading out to the paddle box, but in no way coming in contact with the overflow pipes of the other two tanks. This tank supplies two toilet rooms on the cabin deck and one on the lower deck.

The tanks are all made of iron and each has an opening in the top, about 12 inches in diameter, which is always covered.

On this vessel, as on practically all lake steamers, the same intake system which is used for filling the tanks is frequently used while in harbors to supply water for other purposes. Pollution of an otherwise safe supply of drinking water can therefore easily happen during its passage through a sea cock, pump, and pipe line which may have a short time previously become fouled with harbor sewage.

It will be noted that the above report states that the tank which supplies the water for the washrooms and for flushing the toilets is filled by pumping from directly overboard. This means that the passengers may have the privilege of using dirty harbor water for washing purposes if the ship happens to be lying in port. Not only is this objectionable from an esthetic standpoint, but what is still worse water from these washroom faucets may be used and not infrequently is used for drinking purposes. No comment need be made as to the danger of such a system.

As stated in my reports on other outbreaks, no record is kept on any lake vessel as to when or where water for drinking purposes is taken on board. However, it was learned that the *Huron* obtained her supply from Lake Erie between Cleveland and Detroit, from Lake St. Clair, and from various points in the main body of Lake Huron, in Georgian Bay, and in the North Channel. Irrespective of other more grossly polluted sources which more than likely may have furnished the drinking water, it may be stated that the extensive studies of the Great Lakes by the international joint commission have shown that the western end of Lake Erie is very questionable as a safe source of water supply for ships. The extent and concentration of pollution being so variable, there is every opportunity for a vessel to get sewage-polluted water if she fills her tanks during runs between the various ports in that neighborhood.

Evidence in regard to food, milk, and ice used on board safely excluded any of them as being responsible for an outbreak of the type in question.

Seven cases of typhoid fever, including one death, were reported. Four of these cases were seen personally and detailed data obtained relative to their attacks. The respective dates of onset of definite typhoidal symptoms were given as September 13, September 25, September 29, and October 4. The case which terminated fatally was said to have had its onset of typhoid shortly after the patient's return home from the trip, death occurring on September 23. It may be stated that there was a history in this case of chronic nephritis of long standing. The two other cases were also stated to have developed within a short period after their return home. All the cases had primary diarrheal attacks, beginning while on the ship and continuing intermittently, accompanied by more or less

prostration and general malaise, until the definite typhoid onset. As far as could be determined by careful inquiry on all points, nothing in the histories of these cases tended to show the probability of their having contracted the disease at any place other than aboard the vessel.

Considering all the facts developed in the course of the investigation, I am of the opinion that the typhoid and gastroenteric cases were caused by infection in the water used for drinking purposes on board the *Huron*.

Though this is the first definite outbreak which has been reported as occurring on this steamer, I met several people in the course of my investigation who had been on former trips and had not only themselves had diarrhea but had heard other passengers complain of the same trouble. There were members of the crew also who gave histories of having had more or less persistent diarrhea during the entire season.